The One Card That Gets It All Together

PerCom's CI-812

With just one card, you can interface your S-100 bus computer to a data terminal and cassettes, and you can choose the data rates: 30, 60, 120, or 240 self-clocking bytes per second cassette interfacing, and 300- to 9600-baud data terminal interfacing.

The CI-812 not only combines both functions on one card, it also out-performs the separate interface cards normally required for cassette/terminal interfacing. The result: you pay less for more.

Available from

PERCOM

- ✓ The CI-812 provides the two most commonly required functions on one PC board: cassette interfacing and data terminal interfacing.
- ✓ The CI-812 provides selectable data rates: 30, 60, 120, or 240 KC/biphase-encoded bytes per second for cassette interfacing, and 300- to 9600-baud RS-232 interfacing.
- ✓ The CI-812 is designed with phase-locked/UART data recovery circuitry for extremely dependable, self-clocking data recovery, even with inexpensive audio cassette recorders.
- ✓ The CI-812's independent record-playback circuits accommodate two recorders for simultaneous operations such as cross-filing. Further, program control of recorders is available with an optional DIP reed relay kit.
- ✓ User software modification is minimal, if needed at all.
- ✓ A comprehensive instruction/application manual, with software, is included with each unit.

over

SPECIFICATIONS: CI-812

ENCODING METHOD

'Kansas City' (BYTE) - Biphase standard: Serial start-stop asynchronous with two stop bits, non-saturating, self-clocking synchronous frequency shift. The encoding method is the Biphase-M, or Manchester Code, with varying amounts of redundancy. 300 baud uses 8 cycles of 2400-Hz signal to define a logic 'one' bit, and 4 cycles of 1200-Hz signal for a logic 'zero'. At 2400 baud, a logic 'one' is one cycle of 2400-Hz signal and a 'zero' is one half cycle of 1200 Hz.

DATA RATE (cassette)

Selectable: 300, 600, 1200 or 2400 baud. 300 baud is 'Kansas City Standard' rate. Cassette data rate is independent of Data Terminal rate selection.

ERROR RATE

Typically less than one error per million bytes at 300 baud using premium quality audio tape and well-maintained $50 - $100 cassette tape units. 2400-baud operation should be regarded as experimental although satisfactory performance will be obtained with moderate quality cassette recorders in non-critical applications.

STORAGE CAPACITY

A C-60 cassette will hold 96K bytes at 300 baud or 750K bytes at 2400 baud. Cassettes longer than C-60 are NOT recommended.

COMPUTER INTERFACE

Compatible electrically and physically with the Altair, IMSAI and other computers using the S-100 bus. The CI-812 is I/O driven with selectable I/O address. Control and status is I/O port xxxx xxx0; data is I/O port xxxx xxx1.

DATA TERMINAL INTERFACE

Full duplex, RS-232 levels at 300, 600, 1200, 2400, 4800, or 9600 baud. Selection of Cassette or Data Terminal input is under program control.

CASSETTE AUDIO INTERFACE

Compatible with the Earplug output and the AUX or MIC inputs on most portable cassette recorder/players.

POWER REQUIREMENTS

+8 Vdc ±1 Vdc @ 500 mA (provided by host computer)
−16 Vdc ±1 Vdc @ 20 mA (provided by host computer)

PHYSICAL

Altair/IMSAI/S-100 sized circuit card (10″ × 5.375″). PC card is FR4-G10 epoxy glass, double-sided, 2-oz copper, with plated-thru holes. Edge contacts are gold.

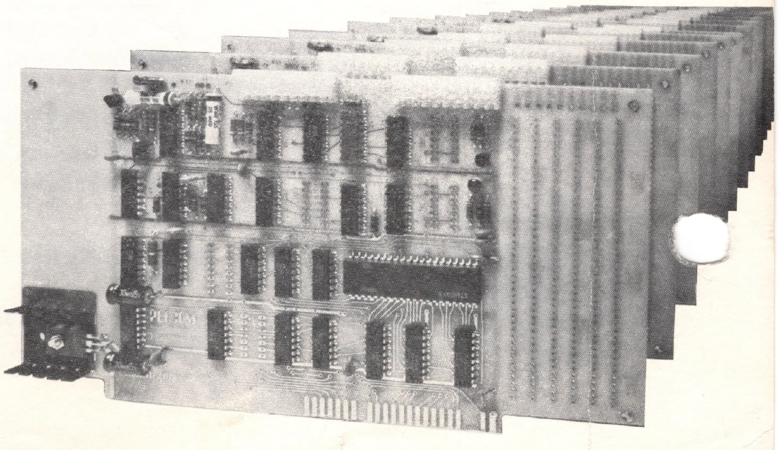
CI-812 (kit)	$89.95.
CI-812 (assembled)	$119.95.
I.C. Socket Kit*	$14.95.
Remote Control Kit	$10.95.
Test Cassette	$4.95.
Instruction Manual (price refunded with order)	$4.00.

*Use of IC sockets not supplied by PerCom will void warranty.

PERCOM

PERCOM DATA COMPANY, INC.
4021 WINDSOR • GARLAND, TEXAS 75042
(214) 276-1968

PerCom *'peripherals for personal computing'*



INTRODUCTION

THE PERCOM CI-812 IS THE ONLY INTERFACE YOU NEED TO COMPLETE YOUR ALTAIR/IMSAI OR SIMILIAR COMPUTER USING THE S-100 BUSS STANDARD. THE CI-812 OUT PERFORMS AND COMBINES THE FUNCTIONS NORMALLY REQUIRING TWO OR THREE MORE COSTLY INTERFACE CIRCUIT CARDS.

IN ADDITION TO THE 300 TO 9600 BAUD FULL DUPLEX DATA TERMINAL INTERFACE, THE CI-812 CONTAINS THE MOST USEFUL, MOST RELIABLE AUDIO CASSETTE INTERFACE YOU CAN BUY. DATA MAY BE RECORDED AND PLAYED BACK ON ORDINARY UNMODIFIED CASSETTE RECORDER/PLAYERS AT 30, 60, 120 OR 240 BYTES/SECOND. 30 BYTES/SECOND IS THE 'KANSAS CITY' STANDARD FOR RELIABLE DATA INTERCHANGE; USE 120 OR 240 BYTES/SECOND TO QUICKLY LOAD YOUR MOST FREQUENTLY USED PROGRAMS.

THE CASSETTE INTERFACE IS COMPATIBLE WITH THE 'KANSAS CITY' OR BYTE STANDARD. THIS PARTICULAR TECHNIQUE FOR RECORDING DATA ON AUDIO CASSETTE RECORDERS WAS SELECTED BY A SYMPOSIUM HELD IN KANSAS CITY, MO. IN THE FALL OF 1975. THE STANDARD IS BASED ON THE EXPERIMENTAL WORK OF DON LANCASTER OF SYNERGETICS AND HAROLD MAUCH OF PERCOM DATA CO.

DATA IS RECORDED ON TAPE, BIT SERIAL WITH A START BIT PRECEDING 8 DATA BITS AND TWO OR MORE STOP BITS. THE LOGIC ONE (MARKING STATE) IS IDENTIFIED AS 8 CYCLES OF A 2400 HERTZ SIGNAL. THE LOGIC ZERO (SPACING STATE) IS 4 CYCLES OF 1200 HERTZ SIGNAL. THE RECOVERED DATA IS SELF CLOCKING, VIRTUALLY ELIMINATING ERRORS CAUSED BY TAPE SPEED VARIATIONS WHICH PLAGUE THE FSK CASSETTE INTERFACES SUCH AS SUDING AND MITS.

ALTHOUGH THE 300 BIT/SECOND (BAUD) RATE WAS CHOSEN TO PROVIDE MAXIMUM RELIABILITY FOR INTERCHANGE OF DATA, THE 'KANSAS CITY' STANDARD IS A HIGHLY (8X) REDUNDANT FORM OF THE BIPHASE-M OR MANCHESTER CODE. A UNIQUE FEATURE OF THE PERCOM CASSETTE INTERFACE IS THE CAPABILITY TO OPERATE AT RATES UP TO 2400 BAUD BY CONTROLLING THIS REDUNDANCY. 2400 BAUD PERMITS A 4K PROGRAM TO BE LOADED IN LESS THAN 20 SECONDS. MOST RELIABLE OPERATION WILL BE OBTAINED AT 300, 600 OR 1200 BAUD.

THIS APPLICATION NOTE CONTAINS INSTRUCTIONS FOR ASSEMBLY, FOR CONNECTION AND USE OF THE CI-812 CASSETTE/TERMINAL INTERFACE.

ASSEMBLY INSTRUCTIONS FOR THE PERCOM CI-812

READ ALL OF THE FOLLOWING INSTRUCTIONS CAREFULLY

BE SURE TO READ THE WARRANTY PARTICULARLY NOTING THE STATEMENTS REGARDING CORROSIVE SOLDER FLUX AND INTEGRATED CIRCUIT SOCKETS.

CHECK THE KIT PARTS AGAINST THE PARTS LIST.

BRUSH BOTH SIDES OF THE PC CARD VIGOROUSLY WITH A DISCARDED TOOTHBRUSH TO REMOVE ANY ETCH SLIVERS WHICH MAY CAUSE INVISIBLE SHORTS.

INSTALL THE COMPONENTS IN THE FOLLOWING ORDER. REFER TO FIGURE 1 FOR COMPONENT LOCATION AND ORIENTATION.

CHECK THE ERRATA SHEETS FOR CHANGES TO THE FOLLOWING PROCEDURE.

RESISTORS:

CHECK	RESISTOR	VALUE	COLOR CODE		
( )	R1	47K ¼W	YL VI OR	BK-BLACK	0
( )	R2	10K	BR BK OR	BR-BROWN	1
( )	R3	100K	BR BK YL	RD-RED	2
( )	R4	10K	BR BK OR	OR-ORANGE	3
( )	R5	68K	BU GR OR	YL-YELLOW	4
( )	R6	4.7K	YL VI RD	GR-GREEN	5
( )	R7	100K	BR BK YL	BU-BLUE	6
( )	R8	10K	BR BK OR	VI-VIOLET	7
( )	R9	10K	BR BK OR	GY-GRAY	8
( )	R10	100K	BR BK YL	WH-WHITE	9
( )	R11	1K	BR BK RD		
( )	R12	180	BR GY BR		
( )	R13	820	GY RD BR		
( )	R14	1K	BR BK RD		
( )	R15	~~470~~ 100	~~YL VI BR~~ BR BL BR		
( )	R16	4.7K	YL VI RD		
( )	R17	47K	YL VI OR		
( )	R18	180	BR GY BR		
( )	R19	10K	BR BK OR		
( )	R20	10K	BR BK OR		
( )	R21	100	BR BK BR		
( )	R22	4.7K	YL VI RD		
( )	R23	1K	BR BK RD		
( )	R24	——	NOT USED		
( )	R25	1K	BR BK RD		
( )	R26	27K	RD VI OR		
( )	R27	10K	BR BK OR		
( )	R28	10K	BR BK OR		
( )	R29	2.7K	RD VI RD		
( )	R30	10K	BR BK OR		

CHECK	RESISTOR	VALUE	COLOR CODE
( )	R31	4.7K	YL VI RD
( )	R32	180 ½W	BR GY BR
( )	R33		NOT USED

DIODES:

( )	CR1	1N914
( )	CR2	* NOT USED
( )	CR3	* NOT USED
( )	CR4	1N759A
( )	CR5	1N914

SOLDER AND CLIP ALL RESISTOR AND DIODE LEADS

CAPACITORS:

CHECK	CAPACITOR	VALUE	TYPE
( )	C1	0.047UF	MYLAR
( )	C2	0.01UF	DISC
( )	C3	150PF	MICA
( )	C4	0.047UF	MYLAR
( )	C5	0.01UF	DISC
( )	C6	750PF	DISC
( )	C7	0.01UF	DISC
( )	C8	0.01UF	DISC
( )	C9	0.01UF	DISC
( )	C10	25 UF	ELECTROLYTIC
( )	C11	0.01UF	DISC
( )	C12	0.01UF	DISC
( )	C13	25 UF	ELECTROLYTIC
( )	C14	0.01UF	DISC
( )	C15	750PF	DISC

TRANSISTORS:

CHECK THE ERRATA SHEETS FOR TRANSISTOR ORIENTATION INSTRUCTIONS. THE ORIENTATION SHOWN ON THE ASSEMBLY DRAWING MAY NOT BE CORRECT FOR THE TRANSISTORS INCLUDED IN THIS KIT.

( )	Q1	2N3565	NPN HIB
( )	Q2	2N5135	NPN
( )	Q3	2N5138	PNP HIB

SOLDER AND CLIP THE CAPACITOR AND TRANSISTOR LEADS.

* THESE COMPONENTS ARE PART OF THE REMOTE CONTROL KIT.

INTEGRATED CIRCUITS:

WARNING: THE USE OF SOCKETS FOR MOUNTING THE INTEGRATED CIRCUITS IS NOT RECOMMENDED. MORE SPECIFICALLY, THE USE OF ANY IC SOCKETS NOT SUPPLIED BY PERCOM DATA CO. MAY VOID THE WARRANTY. IF YOU WISH TO USE SOCKETS, A KIT IS AVAILABLE FROM PERCOM. THESE SOCKETS ARE OF SUBSTANTIALLY HIGHER QUALITY THAN IS AVAILABLE THROUGH SURPLUS OUTLETS.

IF YOU ARE NOT FAMILIAR WITH INTEGRATED CURCUIT INSERTION AND SOLDERING TECHNIQUES, REFER TO APPENDIX A FOR HANDLING INSTRUCTIONS.

CHECK	IC	TYPE
( )	Z1	LM339
( )	Z2	74LS113
( )	Z3	74LS197
( )	Z4	74LS153
( )	Z5	74LS197
( )	Z6	74LS197
( )	Z7	74LS86
( )	Z8	74LS74
( )	Z9	74LS74
( )	Z10	74LS157
( )	Z11	7474
( )	Z12	74LS10
( )	Z13	74LS74
( )	Z14	74LS04
( )	Z15	74LS00
( )	Z16	74LS00
( )	Z17	2502 OR AY5-1013
( )	Z18	74LS197
( )	Z19	NOT USED (110 BAUD OPTION)
( )	Z20	74LS30
( )	Z21	74LS04
( )	Z22	74LS02
( )	Z23	74367
( )	Z24	74367
( )	Z25	74367

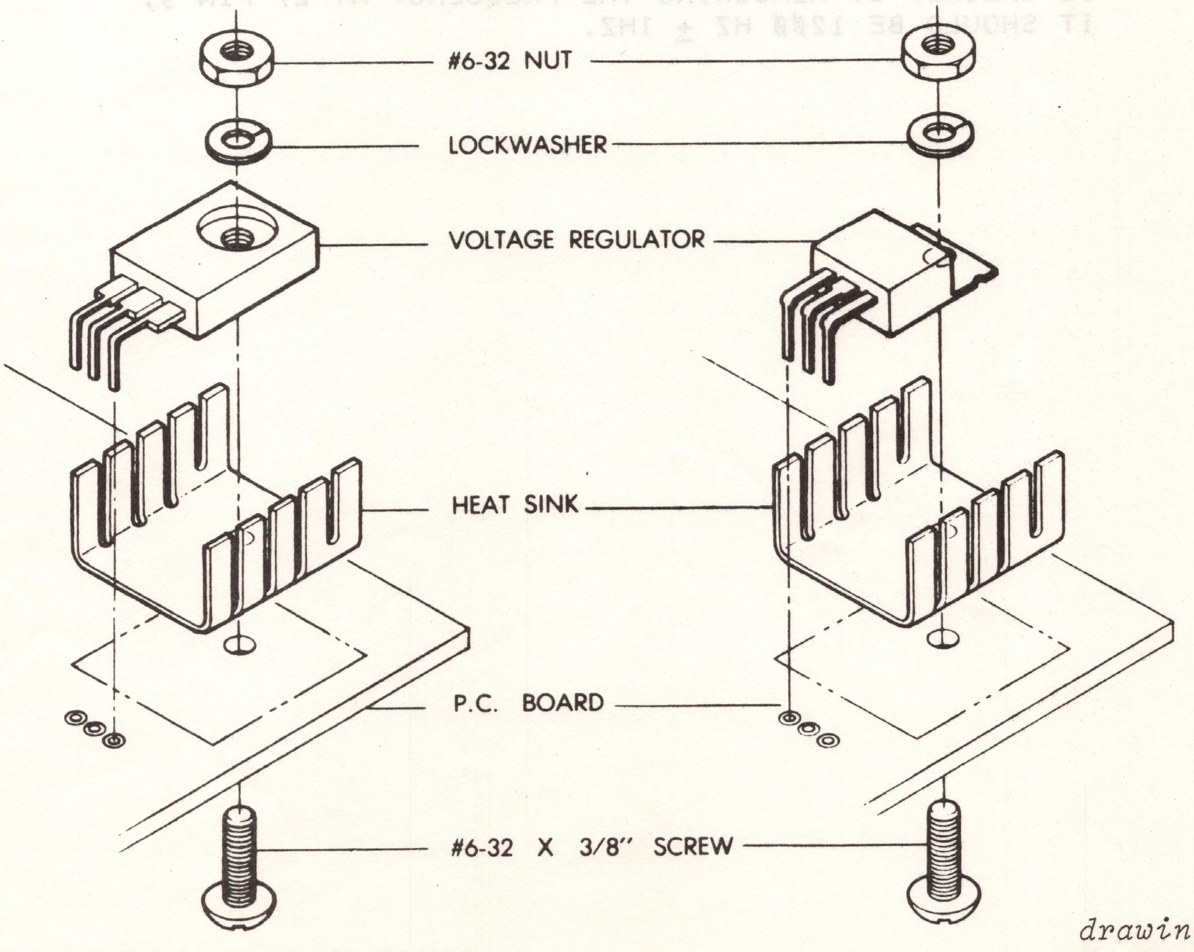
RECHECK ORIENTATION (NOTE THAT ALTERNATE ROWS OF IC'S ARE ORIENTED DIFFERENTLY) AND SOLDER ALL INTEGRATED CIRCUITS

MISC:

( ) 7805 5 VOLT REGULATOR

PLACE THE METAL TAB OF THE REGULATOR OVER THE HOLE IN THE HEAT SINK AREA ON THE LOWER LEFT OF THE CIRCUIT CARD. POSITION THE THREE LEADS OVER THE LEAD FEED THRU HOLES AND NOTE WHERE TO BEND EACH LEAD. BEND EACH LEAD WITH SMALL PLIERS AND CHECK TO SEE THAT WHEN THE LEADS GO THROUGH THE BOARD, THE MOUNTING HOLES LINE UP. INSERT THE 6-32 SCREW FROM THE BOTTOM OF THE BOARD, PLACE THE HEAT SINK OVER THE SCREW FROM THE TOP, INSERT THE REGULATOR LEADS INTO THE BOARD WHILE THE TAB SLIPS OVER THE MACHINE SCREW. USE THE LOCKWASHER AND NUT TO SECURE THE REGULATOR AND HEAT SINK TO THE BOARD. SOLDER THE LEADS AND TRIM.

( ) RT 47K OR 50K TRIMMER RESISTOR
SOLDER IN PLACE
( ) TSA 10 CONTACT TERMINAL STRIP
( ) TSB 10 CONTACT TERMINAL STRIP
SOLDER IN PLACE
( ) CHECK THE ERRATA SHEET AGAIN FOR NECESSARY CHANGES TO THE CIRCUIT



BENDING THE VOLTAGE REGULATOR LEADS

drawing by
VectorGraphics

CIRCUIT ADJUSTMENT

IF THE CI-812 WAS ASSEMBLED FROM A KIT IT WILL BE NECESSARY TO ADJUST THE VCO TRIMMER (RT).

( ) INSTALL THE CI-812 INTO YOUR COMPUTER AND APPLY POWER (NO CONNECTION FROM THE CASSETTE PLAYER).

( ) MEASURE THE VOLTAGE AT TP1 (UPPER LEFT HAND CORNER OF CARD) WITH A HIGH IMPEDANCE (20K OHMS/VOLT) VOLTMETER (CONNECT THE VOLTMETER RETURN TO TSB-10). IT SHOULD BE APPROXIMATELY 2 VOLTS, NOTE THE EXACT READING.

( ) WITH A CLIP LEAD OR PIECE OF WIRE JUMPER FROM THE BOTTOM END OF R17 TO THE TOP END OF C4.

( ) NOTE THE VOLTMETER READING WHILE ADJUSTING TRIMMER RT. AT SOME POINT IN THE ADJUSTMENT THE VCO WILL "JUMP INTO LOCK" AND THE VOLTAGE AT TP1 WILL FOLLOW THE POT ADJUSTMENT. ADJUST THE POT WHILE "IN LOCK" FOR THE SAME VOLTAGE AS WAS MEASURED EARLIER.

( ) REMOVE THE JUMPER.

IF A FREQUENCY COUNTER IS AVAILABLE THE ADJUSTMENT CAN BE CHECKED BY MEASURING THE FREQUENCY AT Z7 PIN 9; IT SHOULD BE 1200 HZ ± 1HZ.

CONNECTING TO THE CI-812:

CASSETTE RECORDER:

FORTUNATELY NEARLY ANY CASSETTE TAPE RECORDER WILL PERFORM WELL WITH CI-812. THE CASSETTE INTERFACE IS COMPATIBLE WITH THE EARPLUG OUTPUT AND AUX OR MIC INPUTS ON MOST PORTABLE CASSETTE RECORDERS. OTHER TYPES OF RECORDERS MAY REQUIRE SOME KIND OF AMPLIFIER BETWEEN THE RECORDER AND CI-812.

EARPLUG: CONNECT THE TAPE RECORDER EARPLUG TO TSA CONNECTOR PIN 5. CONNECT THE RETURN OR SHIELD TO TSA PIN 4 (GROUND).

AUX: CONNECT THE TAPE RECORDER AUX INPUT TO TSA CONNECTOR PIN 2. CONNECT THE RETURN OR SHIELD TO TSA PIN 3 (GROUND).

MIC: NORMALLY CONNECTION TO THE TAPE RECORDER MICROPHONE INPUT IS NOT NECESSARY. THE AUX INPUT IS PREFERRED SINCE IT OPERATES AT A HIGHER SIGNAL LEVEL AND IS LESS SENSITIVE TO NOISE PICKUP. IF THE MIC INPUT IS USED CONNECT TO THE TSA CONNECTOR PIN 1 (INSTEAD OF PIN 2). CONNECT THE RETURN SHIELD TO TSA PIN 3 (GROUND).

WARNING: SOME RECORDERS HAVE COMMON RETURN CIRCUITS ON THE EARPLUG AND INPUT JACKS WHICH MAY CAUSE GROUND LOOP HUM AND NOISE IF BOTH EARPLUG AND AUX (OR MIC) RETURNS ARE EXTERNALLY GROUNDED. IF THIS IS A PROBLEM, DISCONNECT THE AUX RETURN (SHIELD) AND LEAVE IT DISCONNECTED. THE EARPLUG RETURN WILL PROVIDE THE RETURN CIRCUIT. YOU WILL BE ABLE TO HEAR THE NOISE OR HUM IF A SPEAKER IS CONNECTED TO THE 'SIDETONE' OUTPUT (DESCRIBED LATER).

WARNING: SOME RECORDERS LEAVE THE BUILT-IN MICROPHONE ACTIVE EVEN IF A PLUG IS INSERTED INTO THE AUX JACK. THIS WILL ALLOW ROOM NOISE TO 'CLOBBER' YOUR RECORDING. USE THE MICROPHONE JACK OR STICK A 'DUMMY' PLUG INTO THE MICROPHONE JACK TO KILL THE BUILT-IN MICROPHONE.

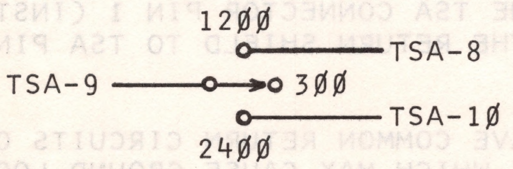
CASSETTE DATA RATE SELECTION:

THE PERCOM CI-812 CASSETTE INTERFACE IS CAPABLE OF OPERATING AT 300, 600, 1200 OR 2400 BAUD. THE DATA RATE IS SELECTED BY PINS 8 AND 10 ON THE TSA CONNECTOR. IF NO CONNECTION IS MADE TO EITHER PIN THE CASSETTE INTERFACE IS CONFIGURED FOR 300 BAUD (K.C. STANDARD). FOR OTHER DATA RATES CONNECT THE PINS AS FOLLOWS:

TSA -8	TSA -10	CASSETTE DATA RATE
NC*	NC	300 BAUD
GND#	GND	600 "
GND	NC	1200 "
NC	GND	2400 "

* NO CONNECTION
# GROUND IS AVAILABLE AT TSA-9

THE DATA RATE IS MOST EASILY CONTROLLED BY CONNECTING A SINGLE POLE 3-POSITION SWITCH AS FOLLOWS:



DATA TERMINAL:

THE CI-812 INCLUDES A FULL DUPLEX DATA TERMINAL INTERFACE AT RS-232 LEVELS FOR 300, 600, 1200, 2400, 4800 OR 9600 BAUD DATA TERMINALS.

( ) CONNECT THE KEYBOARD OR DATA TERMINAL TRANSMITTED DATA (EIA PIN 2) TO TSB-9.
( ) CONNECT THE PRINTER, DISPLAY OR DATA TERMINAL RECEIVED DATA (EIA PIN 3) TO TSB-8.
( ) CONNECT THE DATA TERMINAL SIGNAL RETURN (EIA PIN 7) TO TSB-10. DO NOT CONNECT THE PROTECTIVE GROUND (EIA PIN 1) TO TSB-10, IT SHOULD BE CONNECTED INSTEAD TO THE FRAME OF THE HOST COMPUTER.

THE DATA TERMINAL RATE IS DETERMINED BY AN APPROPRIATE JUMPER IN THE PADS BETWEEN Z9 AND Z10. JUMPER ACROSS THE APPROPRIATE NUMBER. A 7 POLE DIP SWITCH MAY BE INSTALLED IN THE PADS IF DESIRED BUT ONLY ONE SWITCH MAY BE CLOSED AT ANYTIME.

ADDRESS SELECTION:

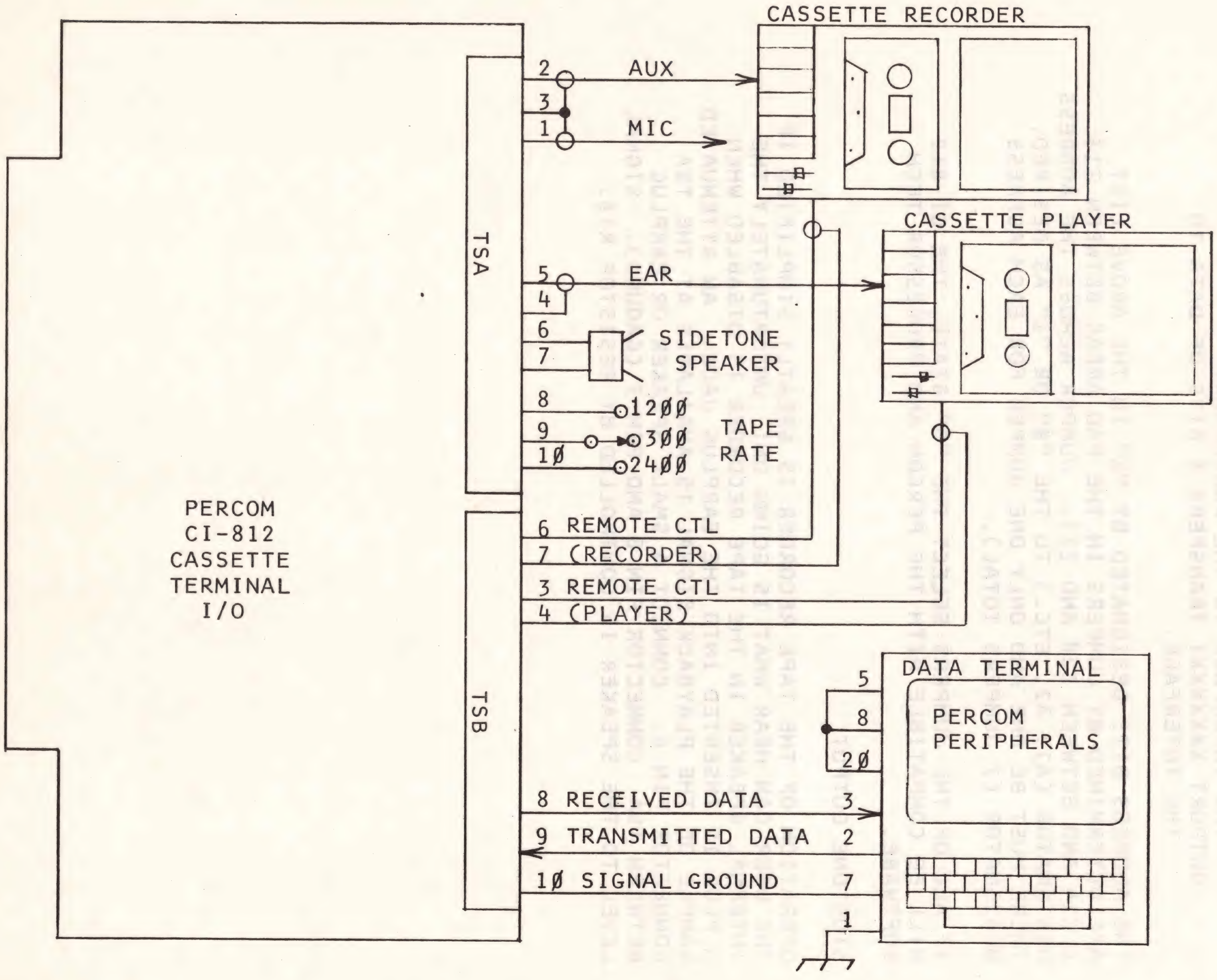
THE CI-812 RESPONDS TO I/O COMMANDS FROM THE PROCESSOR.
INPORT XXXXXXX0 TRANSFERS INTERFACE STATUS TO THE PROCESSOR.
OUTPORT XXXXXXX0 TRANSFERS CONTROL INSTRUCTIONS TO THE INTERFACE.
INPORT XXXXXXX1 TRANSFERS 8 BITS OF DATA FROM THE INTERFACE TO THE PROCESSOR.
OUTPORT XXXXXXX1 TRANSFERS 8 BITS OF DATA TO THE INTERFACE.

THE ADDRESS BITS DESIGNATED BY "X" IN THE ABOVE LIST ARE DETERMINED BY JUMPERS IN THE PAD AREAS BETWEEN Z13 & Z14 AND BETWEEN Z20 AND Z21. JUMPER ACROSS THE ADDRESS DESIGNATOR (A1, A2, ETC.) TO THE "0" OR "1" AS DESIRED. THERE MUST BE ONE AND ONLY ONE JUMPER FOR EACH ADDRESS DESIGNATOR (7 JUMPERS TOTAL).

IF ALL OF THE JUMPERS SELECT THE "O" STATE, THE CI-812 WILL BE COMPATIBLE WITH THE PERCOM AND PROCESSOR TECH SOFTWARE.

SIDETONE OUTPUT

OPERATION OF THE TAPE RECORDER IS GREATLY SIMPLIFIED IF THE USER CAN HEAR WHAT IS GOING ON! UNFORTUNATELY THE INTERNAL SPEAKER IN THE TAPE RECORDER IS DISABLED WHEN A PLUG IS INSERTED INTO THE EARPLUG JACK. AN ATTENUATED SAMPLE OF THE PLAYBACK SIGNAL IS AVAILABLE AT THE TSA CONNECTOR PIN 6. CONNECT A SMALL SPEAKER OR EARPLUG BETWEEN TSA CONNECTOR PIN 6 AND PIN 7 (GROUND). SIGNAL LEVEL TO THE SPEAKER IS CONTROLLED BY RESISTOR R18.



SYSTEM CONFIGURATION

OPERATING PROCEDURE:

CASSETTE SELECTION AND CARE:

THE CHOICE OF CASSETTE TAPE HAS MORE EFFECT ON PERFORMANCE THAN ALL OTHER FACTORS COMBINED. GET THE VERY BEST TAPE YOU CAN BUY. ANYTHING LESS THAN THE BEST WILL RESULT IN MUCH FRUSTRATION. AVOID USING THE C90 AND C120 CASSETTES. THE TAPE IS TOO THIN AND FRAGILE. C60 AND SHORTER ARE MUCH MORE RUGGED AND RELIABLE.

IF THE CASSETTE IS NOT IN USE IT SHOULD BE STORED IN ITS CONTAINER IN A DUST FREE LOCATION. KEEP THE CASSETTE RECORDER SPOTLESSLY CLEAN. CLEAN THE HEAD, CAPSTAN, AND PINCH ROLLER WITH A CLEANING SOLUTION SUGGESTED BY THE EQUIPMENT MANUFACTURER. DO NOT SMOKE IN THE ROOM IN WHICH THE CASSETTE EQUIPMENT IS USED OR STORED.

IT IS IMPOSSIBLE TO ADEQUATELY STRESS THE IMPORTANCE OF BUYING THE VERY BEST QUALITY TAPE AND THEN KEEPING IT AND THE TAPE UNIT CLEAN.

IT IS RECOMMENDED EACH CASSETTE BE THOROUGHLY TESTED BEFORE USE. REFER TO APPENDIX C FOR INSTRUCTIONS.

RECORDING DATA ON TAPE:

1. DO NOT RECORD ON THE FIRST TWO FEET OF TAPE (15 SEC.). THE LEADER-TAPE SPLICE CAUSES A 'RIPPLE' ON ADJACENT LAYERS WHICH MAY CAUSE ERRORS.

2. PREPARE THE COMPUTER TO OUTPUT THE REQUIRED DATA TO THE CASSETTE INTERFACE. DO NOT BEGIN OUTPUTTING THE DATA JUST YET.

3. PLACE THE CASSETTE RECORDER IN RECORD MODE AND START THE TAPE. TURN ON THE AUTOMATIC LEVEL CONTROL OR ADJUST THE RECORDER FOR PROPER SIGNAL LEVEL.

4. ALLOW THE TAPE TO RUN FOR 3 TO 5 SECONDS. THE RECORDER WILL BE RECORDING A 2400 HZ 'LEADIN' TONE ON THE TAPE DURING THIS INTERVAL.

5. WHILE ALLOWING THE TAPE TO RUN, CAUSE THE COMPUTER TO BEGIN TRANSFERRING DATA TO THE CASSETTE INTERFACE.

6. WHEN THE RECORDING IS COMPLETE, LET THE TAPE RUN FOR A FEW SECONDS TO RECORD A 'LEADOUT' TONE.

PLAYBACK:

1. ADJUST THE PLAYBACK SIGNAL LEVEL FOR 4 TO 10 VOLTS PEAK-TO-PEAK. MARK THE VOLUME CONTROL SETTING FOR FUTURE REFERENCE. ADJUST THE TONE CONTROL (IF ONE EXISTS) FOR MAXIMUM RESPONSE. THE VOLUME SHOULD BE ADJUSTED WHILE PLAYING THE 2400 HZ 'LEADIN' TONE PRECEDING A BLOCK OF DATA.

2. LOCATE THE 'LEADIN' 2400 HZ TONE PRECEDING THE DESIRED BLOCK OF DATA. IF A SMALL SPEAKER IS CONNECTED TO THE 'SIDETONE' OUTPUT (TSA CONNECTOR PIN 6), THE TONE CAN BE HEARD WITHOUT PULLING OUT THE EARPLUG LEAD FROM THE CASSETTE PLAYER.

3. BEFORE THE CASSETTE BEGINS OUTPUTTING DATA, PREPARE THE COMPUTER TO ACCEPT THE DATA WHEN IT ARRIVES.

BE CERTAIN THE PLAYBACK IS ONE OR TWO SECONDS INTO THE 'LEADIN' TONE BEFORE ALLOWING THE COMPUTER TO ACCEPT THE PLAYBACK DATA. THIS IS TO AVOID READING THE 'RESIDUALS' FROM PREVIOUS RECORDINGS AND THE 'TRASH' CAUSED BY TURNING THE CASSETTE RECORDER ON AND OFF. SUFFICIENT TIME IS AVAILABLE TO PERFORM THE NECESSARY STEPS IF THE TAPE WAS RECORDED WITH A 3 TO 5 SECOND 'LEADIN' TONE.

4. IF THE RECORDED DATA HAS AN 'END-OF-BLOCK' CODE AT THE END OF THE RECORDED BLOCK OF DATA, THE COMPUTER CAN BE MADE TO AUTOMATICALLY IGNORE THE CASSETTE OUTPUT AFTER THE 'EOB' CODE. IF NO SUCH INDICATION EXISTS, THE USER WILL HAVE TO DISABLE THE COMPUTER BEFORE TURNING OFF THE TAPE TO PREVENT THE TURN-OFF TRANSIENT FROM SENDING CONFUSING 'TRASH' TO THE COMPUTER. OBVIOUSLY A DATA BLOCK TERMINATED WITH SOME FORM OF 'END-OF-BLOCK' INDICATION IS PREFERRED. THE PROGRAM LOADING SOFTWARE CONTAINED IN APPENDIX A PROVIDES PROPER BEGINNING OF BLOCK AND END OF BLOCK INDICATION.

REFER TO APPENDIX B FOR INFORMATION ON SEMIAUTOMATIC OPERATION USING THE CASSETTE RECORDER REMOTE CONTROL JACK.

SOFTWARE CONSIDERATIONS:

ATTACHED TO THIS SECTION ARE SEVERAL PROGRAMS WHICH ILLUSTRATE HOW TO USE THE CI-812. THESE PROGRAMS MAY BE USED IN WHOLE OR AS PART OF YOUR SPECIFIC CASSETTE OPERATING SYSTEM. THE DESIGN OF THE CI-812 IS SUCH THAT IT IS COMPATIBLE, INSOFAR AS POSSIBLE, WITH THE SOFTWARE AVAILABLE FROM PROCESSOR TECHNOLOGY AND IMS ASSOCIATES.

THE CI-812 CONTAINS A UART (UNIVERSAL ASYNCHRONOUS RECEIVER TRANSMITTER) WHICH IS USED TO SEND DATA TO AND RECEIVE DATA FROM THE CASSETTE TAPE UNIT(S) AND THE DATA TERMINAL.

THE UART STATUS IS AVAILABLE VIA INPUT PORT XXXXXXX0 THE "X" REPRESENTS ADDRESS SELECTION JUMPERS WHICH MUST BE INSTALLED ON THE CI-812 TO DETERMINE THE DESIRED ADDRESS TO WHICH THE CI-812 WILL RESPOND. THE PERCOM SOFTWARE IS WRITTEN ASSUMING ALL OF THE ADDRESS SELECTION JUMPERS ARE SET FOR "0".

INPUT PORT XXXXXXX0 BIT 7 IS UART TRANSMITTER BUFFER READY
" 6 IS UART RECEIVER DATA AVAILABLE
" 5 IS UART RECEIVER OVER RUN
" 4 IS UART RECEIVER FRAMING ERROR
" 3 IS UART RECEIVER PARITY ERROR
" 2 IS NOT USED
" 1 IS NOT USED
" 0 IS NOT USED

NORMALLY ONLY BIT 7 (TBMT) AND BIT 6 (DAV) WILL BE EXAMINED TO DETERMINE UART STATUS.

OUTPUT PORT XXXXXXX0 DETERMINES WHETHER THE UART WILL BE CLOCKED BY THE INTERNAL CLOCK AT THE SELECTED DATA TERMINAL OR CASSETTE DATA RATE OR BY THE CLOCK OBTAINED FROM THE CASSETTE TAPE DURING PLAYBACK. IT ALSO DETERMINES WHETHER THE UART RECEIVER WILL GET DATA FROM THE DATA TERMINAL OR FROM THE CASSETTE.

IF BIT 0 IS "ZERO":
A) THE UART RECEIVER WILL BE CONNECTED TO THE DATA TERMINAL (KEYBOARD)
B) THE CASSETTE PLAYBACK WILL BE IGNORED
C) RELAY K1 (IF INSTALLED) WILL BE OFF (DE-ENERGIZED)
D) THE UART RECEIVER AND TRANSMITTER WILL BE CLOCKED AT A RATE DETERMINED BY THE TERMINAL RATE STRAP ON THE CI-812

SOFTWARE CONT'D.

IF BIT 0 IS "ONE":
- A) THE UART RECEIVER WILL BE CONNECTED TO THE CASSETTE DEMODULATOR FOR DATA INPUT
- B) THE DATA TERMINAL KEYBOARD WILL BE IGNORED
- C) RELAY K1 (IF INSTALLED) WILL BE ON
- * D) THE UART RECEIVER WILL BE CLOCKED BY A SIGNAL DERIVED FROM THE TAPE RECORDED DATA (SELF CLOCKING)
- E) THE UART TRANSMITTER WILL BE CLOCKED AT A RATE DETERMINED BY THE LEVELS ON THE CASSETTE RATE SELECTION INPUTS AT TSA-8 AND TSA-10

* Cassette rate selection inputs need to be considered.

IF BIT 1 IS A "ZERO":
- A) RELAY K2 (IF INSTALLED) WILL BE OFF
- B) THE UART TRANSMITTER WILL GENERATE ONLY ONE STOP BIT (TERMINAL MODE)

IF BIT 1 IS A "ONE":
- A) RELAY K2 (IF INSTALLED) WILL BE ON
- B) THE UART TRANSMITTER WILL GENERATE TWO STOP BITS (CASSETTE MODE)

BITS 2 THRU 7 ARE NOT USED.

THE LATCHES WHICH STORE BITS 0 AND 1 ARE SET TO "ZERO" BY A POWER-ON-CLEAR OR RESET FROM THE IMSAI COMPUTER FRONT PANEL.

BIT 0 IS USED PRIMARILY TO SWITCH THE UART BETWEEN THE DATA TERMINAL AND THE PLAYBACK CASSETTE.

BIT 1 IS USED TO CONTROL THE RECORDING CASSETTE (IN A TWO CASSETTE SYSTEM) AND DETERMINE THE NUMBER OF STOP BITS TRANSMITTED BY THE UART.

THE UART TRANSMITTER SENDS DATA TO THE DATA TERMINAL AND CASSETTE SIMULTANEOUSLY. HOWEVER, THE RATE IS CONTROLLED BY BIT 0.

THE ABOVE SYSTEM GIVES CONSIDERABLE FLEXIBILITY FOR BOTH SINGLE AND DUAL CASSETTE SYSTEMS. STUDY IT CAREFULLY AND YOU WILL BE ABLE TO CONFIGURE A SYSTEM WHICH IS OPTIMUM FOR YOUR REQUIREMENTS.

SOFTWARE CONT'D.

TO SELECT THE DATA TERMINAL FOR DATA INPUT:

```
                  XRA  A
                  OUT  0
```

TO SELECT AND TURN ON THE CASSETTE FOR DATA INPUT:

```
                  MVI  A,1
                  OUT  0
```

TO TURN ON THE CASSETTE RECORDER (TERMINAL RATE)

```
                  MVI  A,2
                  OUT  0
```

PORT XXXXXXX1 TRANSFERS DATA TO/FROM THE UART

THE FOLLOWING ROUTINE ILLUSTRATES HOW TO READ A BYTE FROM THE CI-812.

```
          LOOP    IN   0     TEST RECEIVER STATUS (DAV)
                  ANI  40H
                  JZ   LOOP  DO AGAIN IF NOT READY
                  IN   1     GET THE BYTE OR CHARACTER
                  RET
```

TO RECORD OR OUTPUT A BYTE FROM THE PROCESSOR ACCUMULATOR:

```
                  PUSH PSW   SAVE THE BYTE
          LOOP    IN   0     TEST TRANSMITTER STATUS (TBMT)
                  ANI  80H
                  JZ   LOOP  DO AGAIN IF NOT READY
                  POP  PSW   RESTORE THE BYTE
                  OUT  1     OUTPUT THE BYTE
                  RET
```

BOOTSTRAP LOADER

THE FOLLOWING PROGRAM IS SHORT ENOUGH TO BE CONVENIENTLY LOADED BY HAND USING THE FRONT PANEL SWITCHES ON YOUR ALTAIR OR IMSAI COMPUTER. IT LOADS ONE PAGE (256 BYTES) OF DATA AND IS DESIGNED TO OPERATE WITH THE PERCOM CI-812 CASSETTE I/O AND THE PERCOM TEST CASSETTE WHICH CONTAINS AN INTEL FORMAT CHECKSUM LOADER.

TO USE THIS PROGRAM WITH THE PERCOM TEST CASSETTE, LOAD THE PROGRAM BUT DO NOT START IT RUNNING. START THE CASSETTE TAPE AND LET IT RUN UNTIL YOU ARE ONE OR TWO SECONDS INTO THE NULL CODE LEADER. WHILE THE TAPE IS RUNNING START THE BOOTSTRAP PROGRAM (EXAMINE ADDRESS 0000 AND PRESS RUN). WHEN THE LOAD IS COMPLETED THE COMPUTER WILL AUTOMATICALLY BEGIN EXECUTING THE PROGRAM JUST LOADED.

Many IMSAI and ALTAIR Computers destroy the first memory location when reset. If this problem has not been corrected in your computer it will be necessary to relocate the Bootstrap Loader.

```
                          * PERCOM CASSETTE BOOTSTRAP LOADER (8080)*
0000  AF                  XRA   A
0001  6F                  MOV   L,A          INITIALIZE H&L
0002  67                  MOV   H,A
0003  3C                  INR   A
0004  D3 00               OUT   0            SELECT  CASSETTE INPUT
0006  DB 01               IN    1            CLEAR UART
0008  31 1D 00            LXI   SP,STAK      SETUP RETURN ADDRESS
000B  DB 00               IN    0            TEST UART STATUS (DAV)
000D  E6 40               ANI   40H
000F  C8                  RZ                 RETURN-NOT READY
0010  DB 01               IN    1            GET DATA
0012  24                  INR   H            TEST H REGISTER
0013  25                  DCR   H
0014  C2 19 00            JNZ   STR          FIRST NON ZERO BYTE IS
0017  67                  MOV   H,A          PAGE ADDRESS
0018  C9                  RET
0019  77          STR     MOV   M,A          STORE DATA BYTE
001A  2C                  INR   L            BUMP LOAD ADDRESS
001B  C0                  RNZ                GET NEXT BYTE
001C  E9                  PCHL               ALL DONE - NOW EXECUTE
001D  08 00               DW    RTN
```

BOOTSTRAP DUMP

THE FOLLOWING PROGRAM WILL RECORD A PAGE (256 BYTES) OF DATA ON CASSETTE IN A FORMAT WHICH MAY SUBSEQUENTLY BE LOADED INTO THE COMPUTER USING THE BOOTSTRAP LOADER DESCRIBED ON THE PREVIOUS PAGE. SET THE DESIRED PAGE ADDRESS UP ON THE FRONT PANEL SWITCHES (SWITCHES 15 THRU 8 ON THE IMS COMPUTER), START THE PROGRAM RUNNING, START THE CASSETTE RECORDING. LET THE TAPE RUN FOR ABOUT 10-15 SECONDS TO RECORD A NULL CODE LEADER THEN PRESS ANY KEY ON YOUR TERMINAL KEYBOARD. AT 300 BAUD IT TAKES APPROXIMATELY 9 SECONDS TO RECORD A 256 BYTE PAGE. LET THE TAPE RUN AN ADDITIONAL 2-3 SECONDS TO ASSURE A CLEAN RUN OUT.

THE DATA TERMINAL RATE SELECTION STRAP MUST BE SET AT THE RATE YOU WISH THE DATA TO BE RECORDED ON CASSETTE.

```
                  * PERCOM CASSETTE BOOTSTRAP DUMP (8080) *

3D7D  31 FF CF              LXI   SP,SPTR    INITIALIZE STACK POINTER
3D80  DB 01                 IN    1          CLEAR UART
3D82  AF           B1       XRA   A
3D83  6F                    MOV   L,A        INITIALIZE L
3D84  D3 00                 OUT   0          SELECT TERMINAL
3D86  CD A5 3D              CALL  OUT        OUTPUT NULL CODE
3D89  DB 00                 IN    0          TEST KEYBOARD STATUS
3D8B  E6 40                 ANI   40H
3D8D  CA 82 3D              JZ    B1         DO ANOTHER NULL
3D90  DB 01                 IN    1          CLEAR UART
3D92  DB FF                 IN    FF         GET PAGE ADDRESS FROM
3D94  D3 FF                 OUT   FF         PANEL SWITCHES - ECHO
3D96  67                    MOV   H,A        STORE IN H REG
3D97  CD A5 3D              CALL  OUT        OUTPUT PAGE ADDRESS
3D9A  7E           B2       MOV   A,M        GET DATA
3D9B  CD A5 3D              CALL  OUT        OUTPUT
3D9E  2C                    INR   L          BUMP ADDRESS
3D9F  C2 9A 3D              JNZ   B2         GET ANOTHER BYTE
3DA2  C3 82 3D              JMP   B1         BACK TO NULL

3DA5  5F           OUT      MOV   E,A        SAVE BYTE
3DA6  DB 00        T1       IN    0          TEST STATUS (TBMT)
3DA8  E6 80                 ANI   80H
3DAA  CA A6 3D              JZ    T1         KEEP TESTING UNTIL READY
3DAD  7B                    MOV   A,E        RESTORE BYTE
3DAE  D3 01                 OUT   1
3DB0  C9                    RET
```

FEB 10, 1977

PERCOM 8080 MONITOR

THE FOLLOWING PROGRAM IS A CASSETTE OPERATING SYSTEM FOR A COMPUTING SYSTEM CONSISTING OF AN 8080 (OR Z-80) PROCESSOR, PERCOM CI-812 CASSETTE/TERMINAL I/O, AND A 300-9600 BAUD DATA TERMINAL.

THE PROGRAM IS AVAILABLE ON THE PERCOM TEST CASSETTE WHICH ALSO CONTAINS TEST PATTERNS TO VERIFY THE OPERATION OF THE CASSETTE INTERFACE. IT IS ALSO AVAILABLE ON PROM (1702A OR 5204).

THE PROGRAM STARTS WITH A "PHANTOM JUMP" WHICH WILL PERMIT IT TO BE USED ON COMPUTERS WHICH DO NOT HAVE FRONT PANEL SWITCHES. WE USE THIS PROGRAM WITH THE VECTORGRAPHICS PROM/RAM CARD WHICH HAS PROVISION FOR A PHANTOM JUMP START.

WHEN INITIALIZED, THE OPERATING SYSTEM PROMPTS THE USER WITH A QUESTION MARK (?).

EXAMINE MEMORY: (M)

TO EXAMINE A MEMORY LOCATION, TYPE M, THE ADDRESS LOCATION YOU WISH TO EXAMINE, AND A CARRIAGE RETURN. THE PRINTER WILL RESPOND WITH A RETYPE OF THE ADDRESS AND THE CONTENT OF THAT LOCATION.

YOU MAY EXAMINE SUCCESSIVE MEMORY LOCATIONS BY TYPING N.

TO EXAMINE A RANGE OF MEMORY, TYPE M, THE FIRST ADDRESS, SPACE, THE FINISH ADDRESS, AND A CARRIAGE RETURN.

CHANGE MEMORY: (C)

TO CHANGE A MEMORY LOCATION, FIRST EXAMINE THE LOCATION AS DESCRIBED EARLIER THEN TYPE C. THE PRINTER WILL RETYPE THE LOCATION ADDRESS AND WAIT FOR YOUR CHANGE. YOU MAY CHANGE SUCCESSIVE LOCATIONS BY TYPING A SPACE BETWEEN EACH ENTRY. WHEN YOU WISH TO QUIT, HIT CARRIAGE RETURN.

IF YOU MAKE AN ERROR AND DISCOVER IT BEFORE TYPING THE SPACE OR CARRIAGE RETURN, TYPE A SLASH (/). THE PRINTER WILL TYPE THE CURRENT ADDRESS AND GIVE YOU ANOTHER CHANCE. IF YOU HAVE TYPED THE SPACE, TYPE A CARRIAGE RETURN AND START AGAIN AT THE LOCATION IN ERROR.

LOAD A PROGRAM: (L)

TO LOAD A PROGRAM WHICH IS ON CASSETTE IN INTEL ASCII HEX FORMAT, TYPE L. DURING THE LOAD THE PROGRAM CHECKS TO MAKE SURE THE DATA IS BEING WRITTEN INTO MEMORY CORRECTLY. IF AN ERROR OCCURS THE PROGRAM ABORTS THE LOAD, STOPS THE TAPE (IF REMOTE CONTROL OPTION EXISTS) AND TYPES AN M FOLLOWED BY THE MEMORY ADDRESS WHICH DID NOT LOAD CORRECTLY. THIS WILL OCCUR IF YOU TRY TO LOAD INTO A ROM OR INTO A LOCATION WHERE THERE IS NO MEMORY OR IF THE MEMORY IS DEFECTIVE.

THE PROGRAM ALSO WATCHES FOR CHECKSUM ERRORS. IF A CHECKSUM ERROR OCCURS,THE PRINTER WILL TYPE AN X AND THE LAST ADDRESS LOADED.

YOU CAN USUALLY STOP THE TAPE, EJECT THE CASSETTE AND EXAMINE FOR CONTAMINATES. A PHOTOGRAPHERS AIR BULB IS USEFUL FOR BLOWING OFF DUST AND LINT. REINSTALL THE CASSETTE, REWIND A SHORT DISTANCE, AND START THE LOAD AGAIN. IF IT FAILS AT THE SAME POINT AGAIN, THE TAPE (OR RECORDING) IS DEFECTIVE.

VERIFY: (V)

VERIFY WORKS THE SAME AS A LOAD EXCEPT THAT DATA IS NOT WRITTEN INTO MEMORY IT IS COMPARED WITH THE EXISTING MEMORY CONTENT. IF A MISMATCH OCCURS, THE PRINTER PRINTS AN M AND THE ADDRESS OF THE MISMATCH.

DUMP A PROGRAM: (D)

TO DUMP A SECTION OF MEMORY ONTO TAPE IN THE RELOADABLE INTEL ASCII HEX FORMAT, TYPE D, THE START ADDRESS, A SPACE, THE FINISH ADDRESS, AND A CARRIAGE RETURN.

EXECUTE A PROGRAM: (G)

TO SEND THE PROGRAM COUNTER TO A DESIRED PROGRAM TO COMMENCE PROGRAM EXECUTION, TYPE G, THE EXECUTION ADDRESS, AND A CARRIAGE RETURN.

WHEN ENTERING DATA AND ADDRESS INFORMATION FROM THE KEYBOARD IT IS NOT NECESSARY TO TYPE LEADING ZEROS.

NOTICE: IN THIS PROGRAM, THE RATE AT WHICH DATA IS RECORDED ON CASSETTE IS THE SAME AS THE SELECTED DATA TERMINAL RATE. THE PROGRAM DOES NOT SWITCH TO THE CASSETTE RATE WHEN DUMPING TO CASSETTE.